

CLAIMS

What is claimed is:

1. A caching device using an N-way replacement mechanism comprising:
 2. at least one replacement order list with N positions, the at least one replacement order list arranged with a first-to-replace position at one end and a last-to-replace position at the opposite end, each position containing a way number, N way comparators, a control unit, a replacement order generator, and receiving a hit signal and, in case of a hit, a hit way number.
 1. 2. The caching device in claim 1 in which a hit position in the at least one replacement order list is determined by comparing the hit way number with the way number in each of the N positions in the at least one replacement order list using the N way comparators.
 1. 2. 3. The caching device in claim 2 in which the control unit produces replacement order generator control signals using the hit signal and the hit position.
 1. 2. 3. 4. The caching device of claim 3 in which the replacement order generator comprises a replace way selector producing a replace way number and N position selectors, each consisting of a multiplexor with at least two inputs.
 1. 2. 5. The caching device in claim 4 in which the position selector for the last-to-replace position has the hit way number and the replace way number as inputs and the position

3 selectors for the other positions have its own way number and a replace-later adjacent way
4 number from its adjacent position toward the last-to-replace position as inputs.

1 6. The caching device in claim 5 in which the control unit generates the
2 replacement order generator control signals to have the position selector for the last-to-replace
3 position choose the hit way number, the position selectors from the hit position to the position
4 next to the last-to-replace position choose the replace-later adjacent way number, and the
5 position selectors for the remaining positions choose its own way number.

1 7. The caching device in claim 5 in which the control unit generates the
2 replacement order generator control signals to have the position selector for the last-to-
3 replace position choose the replace way number and position selectors for all other positions
4 choose the replace-later adjacent way number.

1 8. The caching device in claim 5 in which the replace way selector always chooses
2 the way number from the first-to-replace position in the at least one replacement order list.

1 9. The caching device in claim 5 in which the control unit generates the
2 replacement order generator control signals to have the replace way selector choose the way
3 number from at least one position in the at least one replacement order list.

1 10. The caching device in claim 4 in which the at least one replacement order list is
2 divided into one or more partitions with each partition arranged with the first-to-replace

3 position at one end and the last-to-replace position at the opposite end of the partition, and the
4 control unit receiving a reference ID indicating a reference partition.

1 11. The caching device in claim 10 in which the reference ID is an N-bit mask,
2 each bit denoting whether or not the associated position is in the reference partition.

1 12. The caching device in claim 10 in which the reference ID is a user identifier,
2 identifying the partition information associated with the reference partition kept in the control
3 unit.

1 13. The caching device in claim 11 or claim 12 in which the position selector for
2 the last-to-replace position of the at least one replacement order list has the hit way number, the
3 replace way number and its own way number as inputs, the position selector for the first-to-
4 replace position of the at least one replacement order list has the replace way number, its own
5 way number and the replace-later adjacent way number as inputs, and the position selector for
6 the remaining positions has the hit way number, the replace way number, its own way number,
7 and the replace-later adjacent way number as inputs.

1 14. The caching device in claim 13 in which the control unit generates the
2 replacement order generator control signals to have the position selector for the last-to-replace
3 positoin in the reference partition choose the hit way number, the position selectors from the
4 hit position to the position next to the last-to-replace position in the reference partition choose
5 the replace-later adjacent way number, and the position selectors for the remaining positions

6 within and outside the reference partition choose its own way number.

1 15. The caching device in claim 13 in which the control unit generates the
2 replacement order generator control signals to have the position selector for the last-to-replace
3 position in the reference partition choose the replace way number, the position selectors for all
4 other positions within the reference partition choose the replace-later adjacent way number,
5 and the position selectors for positions outside the reference partition choose its own way
6 number.

1 16. The caching device in claim 13 in which the control unit generates the
2 replacement order generator control signals to have the position selector for the last-to-replace
3 position in the reference partition choose the hit way number, the position selectors for all other
4 positions within the reference partition choose the replace-later adjacent way number, the
5 position selector for the hit position choose the replace way number, and all other positions
6 outside the reference partition choose its own way number.

1 17. The caching device in claim 13 in which the control unit generates the
2 replacement order generator order signals to have the replace way selector choose the way
3 number from the first-to-replace position in the reference partition.

1 18. The caching device in claim 13 in which the control unit generates the
2 replacement order generator control signals to have the replace way selector choose the way
3 number from at least one position in the at least one replacement order list.

1 19. The caching device in claim 11 or claim 12 in which a user has access to at
2 least two disjoint partitions, the partitions arranged with the first-to-replace partition toward the
3 first-to-replace position of the at least one replacement order list and the last-to-replace
4 partition toward the last-to-replace position of the at least one replacement order list, and the
5 reference ID indicating the at least two disjoint reference partitions.

1 20. The caching device in claim 19 in which the replacement order generator
2 consists of a replace way selector, N position selectors, and a boundary way selector for each of
3 the partition that is not the first-to-replace partition, each boundary way selector choosing the
4 first-to-replace way number in its partition as the boundary way number.

1 21. The caching device in claim 20 in which at least one of the at least two disjoint
2 partitions is accessible by another user.

1 22. The caching device in claim 20 or 21 in which the position selector for the last-
2 to-replace position of the at least one replacement order list has the hit way number, the replace
3 way number and its own way number as inputs, the position selector for the first-to-replace
4 position of the at least one replacement order list has the replace way number, its own way
5 number, the replace-later adjacent way number, and the at least one boundary way number as
6 inputs, and the position selector for the remaining positions has the hit way number, the replace
7 way number, its own way number, the replace-later adjacent way number, and the at least one
8 boundary way number as inputs.

1 23. The caching device in claim 22 in which the control unit generates the
2 replacement order generator control signals to have the position selector for the last-to-replace
3 position in the last-to-replace reference partition choose the hit way number, the position
4 selectors from the hit position to the position next to the last-to-replace position in the last-to-
5 replace reference partition choose the replace-later adjacent way number, and the position
6 selectors for the remaining positions choose its own way number.

1 24. The caching device in claim 22 in which the control unit generates the
2 replacement order generator control signals to have the position selector for the last-to-replace
3 position in the last-to-replace reference partition choose the hit way number, the position
4 selectors for the remaining positions in the last-to-replace reference partition choose the
5 replace-later adjacent way number, the position selector for the last-to-replace position in the
6 first-to-replace reference partition choose the boundary way number, the position selector from
7 the hit position to the position next to the last-to-replace position in the first-to-replace
8 reference partition choose the replace-later adjacent way number, and the position selectors for
9 remaining positions in the first-to-replace reference partition and outside the reference
10 partitions choose its own way number.

1 25. The caching device in claim 22 in which the control unit generates the
2 replacement order generator control signals to have the position selector for the last-to-replace
3 position in the last-to-replace reference partition choose the replace way number, the position
4 selector for the last-to-replace position in the first-to-replace reference partition choose the
5 boundary way number, the position selectors for all other positions within the reference

6 partitions choose the replace-later adjacent way number, and the position selectors for positions
7 outside the reference partitions choose its own way number.

1 26. The caching device in claim 22 in which the control unit generates the
2 replacement order generator control signals to have the replace way selector choose the way
3 number from the first-to-replace position in the first-to-replace reference partition.

1 27. The caching device in claim 22 in which the control unit generates the
2 replacement order generator control signals to have the replace way selector choose the way
3 number from at least one position in the at least one replacement order list.

1 28. The caching device in claim 4 in which the at least one replacement order list
2 has a lock register, indicating the positions in the at least one replacement order list that are
3 locked, and the control unit receiving the value of the lock register.

1 29. The caching device in claim 28 in which the at least one replacement order list
2 is divided into unlocked and locked partitions, with the unlocked partition arranged with the
3 first-to-replace position at one end and the last-to-replace position at the opposite end of the
4 partition, and the lock register indicating the number of positions in the locked partition.

1 30. The caching device in claim 29 in which the control unit generates the
2 replacement order generator control signals to have the position selector in the last-to-replace
3 position in the unlocked partition choose the hit way number, the position selectors from the hit

4 position to the position next to the last-to-replace position in the unlocked partition choose the
5 replace-later adjacent way number and the position selectors in the remaining positions choose
6 its own way number.

1 31. The caching device in claim 29 in which the control unit generates the
2 replacement order generator control signals to have the position selector in the last-to-replace
3 position in the unlocked partition choose the replace way number, the position selectors in the
4 remaining positions in the unlocked partition choose the replace-later adjacent way number and
5 the position selectors in the locked partition choose its own way number.

1 32. The caching device in claim 29 in which the number in the lock register is
2 changed to the next higher value when a lock command is performed.

1 33. The caching device in claim 29 in which the control unit generates the
2 replacement order generator control signals to have the position selector in the first-to-replace
3 position in the locked partition to choose the hit way number, the position selector in the hit
4 position to choose the replace way number, which is from the first-to-replace position in the
5 locked partition, and the position selectors in the remaining positions choose its own way, and
6 the number in the lock register is changed to the next lower value.

1 34. The caching device in claim 29 in which the control unit generates the
2 replacement order generator control signals to have the position selector in the last-to-replace
3 position in the at least one replacement order list choose the hit way number, the position

4 selectors from the hit position to the position next to the last-to-replace position in the at least
5 one replacement order list choose the replace-later adjacent way number, and the position
6 selectors in the remaining positions choose its own way number, and the number in the lock
7 register is changed to the next higher value.

1 35. The caching device in claim 29 in which the control unit generates the
2 replacement order generator control signals to have the position selector in the last-to-replace
3 position in the at least one replacement order list choose the replace way number and the
4 position selectors in the remaining positions in the at least one replacement order list choose
5 the replace-later adjacent way number, and the number in the lock register is changed to the
6 next higher value.

1 36. The caching device in claim 29 in which the replace way selector always
2 chooses the way number from the first-to-replace position in the unlocked partition.

1 37. The caching device in claim 29 in which the control unit generates the
2 replacement order generator control signals to have the replace way selector choose the way
3 number from at least one position in the at least one replacement order list.

1 38. The caching device in claim 3 in which the replacement order generator
2 consists of N position selectors, each selector having the way number from each of the N
3 positions as inputs.

1 39. The caching device in claims 4 or 38 in which the control unit is implemented
2 using random access memory or reprogrammable logic array.

1 40. The caching device in claims 4 or 38 is an instruction cache.

1 41. The caching device in claims 4 or 38 is a data cache.

1 42. The caching device in claims 4 or 38 is a combined instruction and data cache.

1 43. The caching device in claims 4 or 38 is an instruction TLB.

1 44. The caching device in claims 4 or 38 is a data TLB.

1 45. The caching device in claims 4 or 38 is a combined instruction and data TLB.

1 46. The caching device in claims 4 or 38 is a texture map cache in a graphics
2 system.

1 47. The caching device in claims 4 or 38 is used in a single processor system.

1 48. The caching device in claims 4 or 38 is used in a multiple processor system.

1 49. The caching device in claims 4 or 38 is used in a multithreaded system.

50. A data processing system adapted to include a caching device; the caching device comprising:

at least one replacement order list with N positions, the at least one replacement order list arranged with a first-to-replace position at one end and a last-to-replace position at the opposite end, each position containing a way number, N way comparators, a control unit, a replacement order generator, and receiving a hit signal and, in case of a hit, a hit way number.

51. The data processing system in claim 50 in which the replacement order generator consists of N position selectors, each selector having the way number from each of the N positions as inputs.

52. The data processing system in claim 51 in which the control unit is implemented using random access memory or reprogrammable logic array.

53. A method for providing a replacement mechanism in a caching device comprising the steps of:

- (a) providing at least one replacement order list with N partitions; and
- (b) arranging the at least one replacement order list with a first to replace position at one end and a last to replace position at an opposite end, each position containing a way number, Nway comparators, a control unit, replacement order generator.